

ATHLETE PERCEPTIONS AND PHYSICAL PERFORMANCE EFFECTS OF THE FIFA 11+ PROGRAM IN 9-11 YEAR-OLD FEMALE SOCCER PLAYERS: A CLUSTER RANDOMIZED TRIAL

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ABSTRACT

Background: Strong evidence supports the use of the FIFA 11 + injury risk reduction warm-up program among soccer players, but few studies have investigated its impact on physical performance and movement control in athletes younger than 12 years of age, or the athletes' opinions of participating in the program.

Purpose: The primary purpose of this study was to measure the impact of the FIFA 11 + program on movement control [Landing Error Scoring System (LESS) and Y-Balance test (YBT)], agility, vertical jump (VJ) height, and trunk muscle endurance compared to a standard warm-up in pre-teen female athletes over one indoor soccer season. A secondary purpose was to assess the athletes' tolerance and enjoyment of the program.

Study Design: Cluster randomized controlled trial.

Methods: All six teams in the U10 and U11 female divisions of a developmental-level soccer club were cluster randomized to the FIFA 11 + program intervention group or the control group. Participants in the control group continued with a coach-determined warm-up for the duration of a five-month indoor soccer season. Pre- and post-season participants underwent physical testing using the agility T-test, Belt Mat vertical jump (VJ), and static plank tests; and two measures of neuromuscular control (LESS, YBT). Following the soccer season, the athletes in the intervention group also completed a bespoke Tolerance and Enjoyment questionnaire.

Results: The 11 + group (n=25) increased their mean static plank hold time by 26.1 ± 38.5 seconds compared to the control group (n=18), who only increased by 2.1 ± 37.1 seconds ($p=0.047$). For all athletes, there were improvements in mean LESS score (0.6 ± 1.3 , $p=0.003$), and T-test time (0.4 ± 0.7 , $p=0.001$); however, YBT scores worsened by approximately 2% from pre- to postseason. No differences were found for VJ. Athletes tolerated the program well, but the majority described the enjoyment of completing the program as moderately low.

Conclusion: This study suggests that the 11 + program may improve some aspects of physical performance in 9-11 year-old female soccer players, but the low enthusiasm for the program could have longer term adherence implications.

Level of Evidence: 2b

Key Words: female athletes, FIFA 11 +, injury prevention, movement system, physical performance

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INTRODUCTION

Soccer (or football) is a popular sport, with 265 million players globally, including 5 million registered in North America alone.¹ Overall participation rates have increased, especially among female players.¹ Injuries sustained during soccer play can range from 5.5 to 65.8 per 1000 hours of participation and are greater in younger (13-15 years of age) versus older adolescents (16-18 years of age).² Compared to male athletes, female athletes are at higher risk of incurring certain injuries such as rupture of the anterior cruciate ligament (ACL) of the knee.^{3,4} The disparity in non-contact ACL injury rates begins to emerge around the age of 12-13 years.⁵ In addition to the short term consequences of pain and disability, ACL tears are associated with a decreased level of sport participation⁶ and early onset osteoarthritis.⁷

Neuromuscular control of the trunk and proximal body segments play a role in avoiding body positions (e.g., increased knee valgus) which are associated with non-contact ACL injury.^{8,9} Deficits in movement control can be identified with tests like the Y-Balance Test (YBT) and the Landing Error Scoring System (LESS), which have shown association with increased lower extremity and ACL injury risk in some studies^{10,11} and are conducive to use by clinicians. To address movement control deficits a number of risk reduction programs have been developed,¹² including one specific to the sport of soccer.¹³ The Fédération Internationale de Football Association (FIFA), through their FIFA Medical Assessment and Research Centre (F-MARC), developed the FIFA 11+ (or 11+) program which was designed to replace a standard warm-up and targets trunk muscle endurance, strength, balance, and agility while emphasizing good biomechanical movement patterns.¹³ The program continues to be endorsed by national soccer associations¹⁴ and utilized by the soccer community due to its demonstrated success in decreasing the number of injuries by up to 39%.^{15,16} However, success of the program is not universal,¹⁷ and seems to be influenced by a number of factors, including the frequency and duration of use.¹⁸

The 11+ program states that it was developed for athletes 14 years of age and over;¹³ however, no justification for that age limit can be found and evidence suggests that risk reduction programs are more

effective if introduced at a younger age.¹⁹ A newer program, FIFA 11+ Kids, was developed to address the higher frequencies of bone and upper extremity injuries in 7-12 year old soccer athletes and has proven successful in decreasing overall injury rates.²⁰ However, this program is distinctly different, in that it omits the muscle strength and endurance exercises (e.g., front and side plank, squats, Nordic hamstring exercise) included in Section 2 of the original 11+ program.¹³ Strength training is imperative for ACL injury risk reduction.¹⁹

Limited studies have used the FIFA 11+ injury risk reduction program with athletes younger than 12 years of age. The predecessor to the FIFA 11+ program, the FIFA 11, was safely used (excluding one strength activity, the Nordic hamstring exercise) to improve jumping and sprinting performance in male athletes as young as ten years of age.²¹ Research has repeatedly shown that strength-building exercises, such as those found in Section 2 of the 11+ program, are safe and effective for children²² despite pervasive myths to the contrary. In fact, current thinking suggests that introducing resistance training activities at a younger age takes advantage of a key window for optimal physical development.²³ Participating in the original 11+ program in its entirety should not place younger athletes at risk, as the activities are monitored, scaled according to ability, and gradually increased in intensity.

Two recent studies safely employed the full 11+ program with 10-12 year old female athletes; however, outcomes were limited to lab based biomechanical measures.^{24,25} Both peak knee valgus moment and knee valgus angle at initial contact during a jump task showed an improvement after eight weeks of participation in the 11+. Interestingly, younger athletes (10-12 years of age) demonstrated a significantly greater improvement in both measures compared to older athletes (14-16 years of age),²⁵ indicating that the 11+ program can be used safely and effectively with athletes younger than 14 years of age.

In addition to injury risk reduction, the 11+ program can also have benefits directly related to skills required on the soccer pitch, which may promote uptake of the program among coaches and athletes.²⁶ Improved agility,²⁷⁻²⁹ balance,^{28,30-32} sprint speed,²⁸ jump height,²⁷ and muscle strength^{29,33,34} have all

been documented in soccer athletes after participation in the 11+ program. However, only one of these studies involved female athletes,³⁰ and those athletes were older adolescents (13-18 years of age).

Given that the ACL injury rate disparity between female and male athletes emerges around the age of 12-13 years and that the early introduction of risk reduction programs containing strength exercises may decrease ACL injury risk, an evaluation of the effects of the original 11+ program on female soccer athletes younger than 12 years of age is warranted. Therefore, the primary purpose of this study was to measure the impact of the FIFA 11+ program on movement control (LESS and YBT), agility, vertical jump (VJ) height, and trunk muscle endurance compared to a standard warm-up in pre-teen female athletes over one indoor soccer season. A secondary purpose was to assess the athletes' tolerance and enjoyment of the program. It was hypothesized that the girls in the FIFA 11+ group would demonstrate greater improvements in LESS & YBT score, agility, VJ, and trunk muscle endurance measures compared to the control group after the soccer season and that the program would be well-tolerated.

METHODS

Participants

The aim was to recruit all girls in the U10 and U11 age groups of a developmental level city soccer club for participation in the study. An email invitation was sent via club administration to the coaching staff and parents of the six teams. Girls were excluded from the study if they self-reported any injury or condition that currently restricted their participation in sport. Of the 58 girls in the U10 and U11 age groups a total of 47 expressed interest in the study, were found eligible to participate, and completed pre-season testing related to the study (Figure 1). Written informed consent and assent was obtained from the parents and athletes, respectively. The study was approved by the University Research Ethics Board, and registered (ClinicalTrials.gov Identifier: NCT02422771) before any recruitment or testing activities were initiated.

A parallel, cluster randomized controlled trial design was used to compare the effects of the 11+ with a standard warm-up. After pre-season testing and prior

to randomizing the teams, it was discovered that two of the teams would be practicing together under the same coaches for the duration of the indoor soccer season and so they were treated as one team. The resulting five teams were then randomly designated to the 11+ intervention group (IG) or the control group (CG) by picking each team's name out of a hat. Forty girls in total were required for sufficient power to detect a difference of 1.0 in LESS score between groups³⁵ (standard deviation (SD) of 1.1,³⁶ alpha of 0.05 and desired power of 0.8).

Outcome Measures

At the beginning of October, before commencement of the season, and again within one week of playing the last game of the indoor soccer season (early March), all participants underwent an hour-long testing circuit at a community recreational facility. The sessions began with measuring the athlete's standing and sitting height, and body mass with a portable stadiometer and scale (Seca, Chino, CA), and leg length, using established protocols.³⁷ The athlete then warmed-up with a standardized five minutes of dynamic exercises including skipping and side shuffles. Testing proceeded in the order below for each athlete. Each test was explained and demonstrated by one of four blinded, trained assessors before the athlete started practice trials. The same assessor supervised the same testing station at pre- and post-testing, and participated in pilot testing prior to the study to ensure consistency. One assessor was assigned to each of the LESS, T-test, and YBT stations; the VJ and static plank were combined into one station and performed by one assessor.

Landing Error Scoring System (LESS). The athlete jumped forward off a 30 cm high box, landed on both feet at a horizontal distance of 50% of her standing height from the box, and then jumped straight up as high as possible.³⁵ The task was videotaped by two HERO 4 Silver cameras (GoPro, Inc., San Mateo, California, USA); one captured the frontal plane and one the sagittal plane view. Three practice trials were allowed, followed by a minute rest, and then three test trials. A trial was repeated if the jump was not completed in one smooth, continuous motion. Intrarater reliability for the LESS is reported as excellent.³⁵

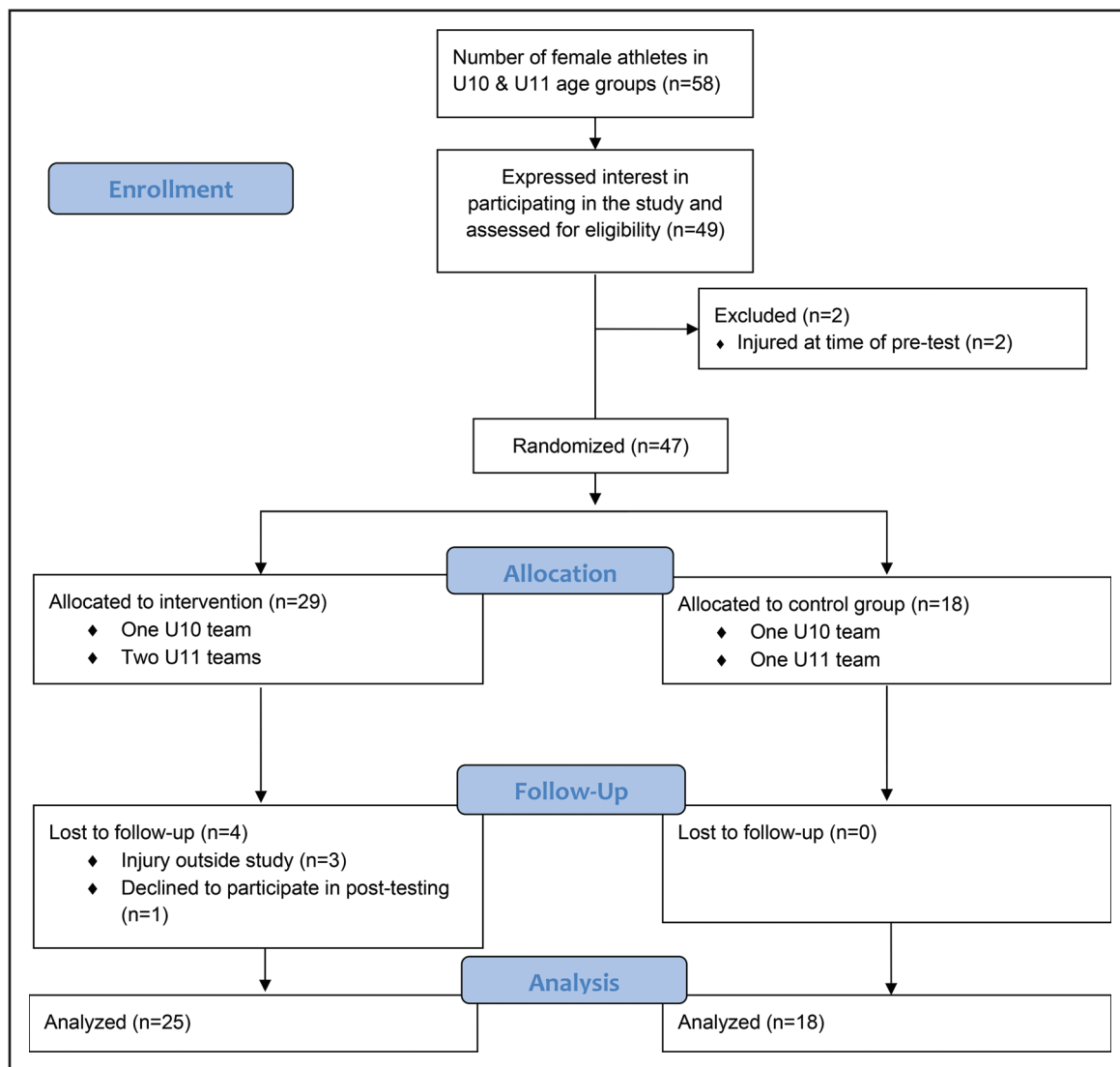


Figure 1. Flow chart outlining athlete participation.

T-test for agility. The athlete sprinted forward 10 meters (m) and touched a cone. She then side shuffled to the left for 5 m, right for 10 m, and left for 5 m before back pedaling to the start/finish line. Overall time was recorded with electronic timing gates (Brower Timing Systems, Draper, Utah). The athlete was allowed two submaximal practice runs before two test trials were completed, separated by two minutes of rest.³⁸ This is a reliable and valid test of agility.³⁹

Vertical jump. The athlete stood on a Vertical Jump Mat (Sport Books Publisher, Toronto, Canada), with a belt clipped around her waist connecting a measuring tape to the mat. The athlete performed a counter-movement jump, and the VJ height was recorded from the tape. Two practice trials were completed

before 3 test trials. The athlete rested 15 seconds between each test trial.²¹ A trial was repeated if the landing strayed from the mat's footprint. The jump mat is a valid method of measuring VJ height.⁴⁰

Static plank. While lying prone on a mat, the athlete supported her bodyweight on the elbows and toes for as long as possible. The athlete had one five-second practice trial and a 15 second rest before one test trial was completed. She was allowed one deviation from the proper position as long as she corrected herself immediately. When she was unable to hold her body in a straight line from head to feet, the trial was stopped and the stopwatch time recorded. This test is a reliable and valid measure of trunk muscular endurance for this age group.⁴¹

Y-Balance test. Using a professional YBT test kit, (Functional Movement Systems Inc., Chatham, Virginia) the athlete, with her shoes removed, was instructed to stand on the left leg. The hands stayed on the hips and the foot of the stance leg remained in contact with the center block while pushing a wood block as far as possible with the right leg. Four practice trials were performed in each of the three test directions (anterior, posteromedial and posterolateral) before three test trials were conducted.⁴² The protocol was then repeated on the right leg. The maximal reach distance obtained in each direction was summed and normalized to limb length to reach a composite score for each leg.⁴³ The YBT has shown good reliability in young soccer players.⁴⁴

Tolerance and Enjoyment questionnaire. Following physical testing at the end of the season, athletes completed a five-minute questionnaire (Appendix A) concerning their perceptions of the 11 + program. The questionnaire was created specifically for this study, with the 7-point scale regarding perceived pleasantness of the 11 + program adapted from a previous study.⁴⁵ Each girl completed the questionnaire individually after instructions were provided by one of the study staff. Numbered printouts showing pictures of all the FIFA 11 + exercises were used by the athletes to identify the components of the program they found the easiest and hardest to complete, their most and least favorite exercises, and any exercises they could not complete.

Intervention

The 11 + program¹³ consists of 15 exercises broken into three sections; 1) slower running drills incorporating dynamic stretching, 2) strength, agility, balance, and jumping exercises, and 3) faster sprints including cutting maneuvers. The program is designed to replace a traditional warm-up and is purported to take 20 minutes to complete.¹³ With these younger girls, it usually took closer to 30 minutes to complete the entire warm-up. Throughout the exercises, emphasis was placed on maintaining a flexed athletic stance, good knee alignment, and soft landings.¹³ The IG teams in this study followed the full, original 11 + program.

The week after baseline testing was complete, three members of the research team (who are registered

physiotherapists) attended a practice for each of the IG teams. After explaining and demonstrating the exercises, the athletes and the coaches were led through the 11 + program. Coaches were given a laminated 11 + manual⁴⁶ and instructed to guide the athletes through the full warm-up prior to all practices, and Sections 1 and 3 of the program before games.¹³ Teams were scheduled to have one to two practices and one game per week. A physiotherapist attended a team practice about once per week to answer questions, and monitor the program, but the coaches directed the warm-up. The athletes were progressed in the difficulty of the exercises as a group, as soon as each girl showed proficiency at each level. The coach made the decision when to progress an exercise with occasional input from the physiotherapist. The girls were instructed to do the more basic exercise if they couldn't perform the progressed version. The two CG teams performed coach-determined warm-ups, lasting about 10 minutes. All teams in the study used an attendance monitoring system (Team-Snap, Inc., Boulder, CO) from which the number of practices and games attended by each athlete was estimated.

Statistical Analysis

Data were analyzed using IBM SPSS Statistics 22 (IBM Corporation, Armonk, NY) and SigmaPlot 12.5 (Systat Software, Inc., San Jose, CA). Data were checked for normality and demographics for the participants were calculated using mean \pm standard deviation for normal data, and median (range) for non-normal data. As a measure of physical maturity, years away from Age of Peak Height Velocity (APHV) was calculated using a validated protocol.³⁷ Baseline demographics and attendance were compared between groups using parametric (independent t-tests) or non-parametric (Mann-Whitney U tests) analyses as appropriate.

For the LESS test, the video of the initial jump landing was scored using a 17-point scale³⁵ by a blinded, trained assessor after all pre- and post-testing was complete. The average LESS score of the three test trials for each participant was used in analyses. The fastest time for the T-test,³¹ the best of the three test trials for the VJ,⁴⁷ and the total plank hold time,⁴¹ were used in analyses for the other performance

outcomes. Pearson Product Correlation Coefficients were calculated to identify possible covariates to be used in analysis of the primary outcome variable (LESS score). Separate two factor Mixed Model Analyses of Variance (ANOVA) were used to compare LESS, YBT, agility, VJ, and trunk muscle endurance of the groups over time. The influence of previous exposure to the FIFA 11+ program on LESS scores was examined by removing those athletes with prior experience and repeating the Mixed Model ANOVA. Significance was set at $p \leq 0.05$. Effect sizes were calculated for each variable for each group using baseline and post-season values.⁴⁸ For the questionnaire responses, the exercises they reported as hardest, easiest, most, and least favorite, and the rating of how pleasant the athletes found the 11+ program, were collated using descriptive statistics.

RESULTS

The data for the 43 athletes who completed both test sessions (Figure 1) were used in analyses for the physical tests, except for the YBT, where data were available for only 39 athletes. One athlete was unable to complete the post-test YBT due to an injury suffered outside the study, and three athletes, because of time constraints, did not undertake the YBT at pre- or post-testing. Data from the 25 athletes in the IG were used in analyses of the questionnaire responses, with

the exception of question #2, where one athlete provided more than the three requested answers.

Participant demographics can be found in Table 1. Baseline age, height, mass, and APHV, as well as attendance rates, were not significantly correlated with change in LESS (Table 1) and so were not included as covariates. Eleven girls (CG = 6, IG = 5) reported participation in the 11+ program within the six months prior to the start of the study. Removing them from analyses did not change the results for the primary outcome measure (decrease in LESS score with time for all athletes, $p = 0.003$; no significant interaction, $p = 0.53$), so they were included in the final results.

There were no differences found between the groups in LESS or YBT scores, T-test time, or VJ height after the indoor soccer season (Table 2). However, static plank hold time in the IG increased significantly, and demonstrated a medium effect size⁴⁹ compared to the CG. All the girls, regardless of group, improved their LESS score and T-test agility time over the indoor season; however performance on the YBT decreased (Table 2). Effect sizes for these outcomes can be considered small.⁴⁹

About half of the athletes described the 11+ program as “slightly pleasant”, “neither pleasant or

Table 1. Participant Characteristics^a

| Baseline Characteristic | Total (n = 43) | IG (n = 25) | CG (n = 18) | p-value | Correlation with Change in LESS Score | p-value of Correlation |
|---|-----------------|------------------|-----------------|--------------------|---------------------------------------|------------------------|
| Age (yrs) | 11.1 (9.5-11.7) | 11.1 (10.1-11.7) | 10.8 (9.5-11.7) | 0.54 | 0.06 | 0.71 |
| Height (cm) | 145.5 ± 8.3 | 147.5 ± 8.6 | 142.9 ± 7.7 | 0.07 | -0.17 | 0.28 |
| Mass (kg) | 38.1 ± 6.9 | 39.0 ± 7.7 | 37.0 ± 6.2 | 0.38 | 0.09 | 0.57 |
| Years away from Age of Peak Height Velocity | 0.05 ± 0.7 | 0.2 ± 0.7 | -0.1 ± 0.7 | 0.12 | -0.04 | 0.78 |
| Participation in soccer (yrs) | 5.0 (2-8) | 5.0 (2-8) | 5.0 (3-8) | -- ^c | -- | -- |
| Participation in other sports during study period (number) | 1.0 (0-3) | 1.0 (0-3) | 1.0 (0-3) | -- ^c | -- | -- |
| Practice & game attendance (%) | 85.7 (53.3-100) | 82.4 (53.3-100) | 94.4 (77.8-100) | 0.001 ^b | -0.10 | 0.51 |
| Practice & game attendance (number) | 37 (24-57) | 36 (24-57) | 44.5 (29-52) | 0.47 | 0.02 | 0.92 |
| IG= Intervention Group; CG=Control Group. | | | | | | |
| ^a Values for normally distributed data are presented as mean ± SD. Non-normal data are presented as median (range). ^b Groups are significantly different. ^c Unable to compute. | | | | | | |

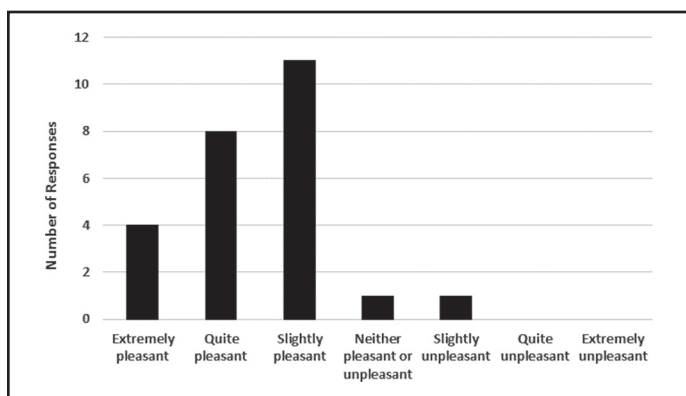
Table 2. Movement Control and Performance Results^a

| | | IG | CG | Groups combined | <i>p-values</i> | | |
|---|-------------|--------------------------------|-------------------|---------------------|-----------------|---------------------|--------------------|
| | | | | | Group | Time | Group x Time |
| LESS | Baseline | 6.9 ± 1.6 | 6.6 ± 1.7 | 6.8 ± 1.6 | 0.66 | 0.005 ^b | 0.63 |
| | Postseason | 6.2 ± 1.6 | 6.1 ± 1.3 | 6.2 ± 1.4 | | | |
| | Effect size | 0.44 (-0.13,0.99) ^c | 0.33 (-0.33,0.98) | 0.40 (-0.03,0.82) | | | |
| YBT right leg composite score (%) | Baseline | 94.8 ± 7.0 | 97.2 ± 7.5 | 95.8 ± 7.2 | 0.48 | 0.02 ^v | 0.39 |
| | Postseason | 93.4 ± 8.1 | 94.2 ± 6.8 | 93.7 ± 7.5 | | | |
| | Effect size | 0.18 (-0.4,0.76) | 0.42 (-0.29,1.11) | 0.29 (-0.16,0.73) | | | |
| YBT left leg composite score (%) | Baseline | 96.4 ± 6.4 | 97.2 ± 7.7 | 96.7 ± 6.9 | 0.82 | 0.009 ^b | 0.70 |
| | Postseason | 94.5 ± 6.7 | 94.6 ± 7.1 | 94.5 ± 6.8 | | | |
| | Effect size | 0.29 (-0.3,0.87) | 0.35 (-0.36,1.04) | 0.32 (-0.13,0.76) | | | |
| T-test (sec) | Baseline | 14.2 ± 1.1 | 14.2 ± 1.3 | 14.2 ± 1.2 | 0.86 | <0.001 ^b | 0.93 |
| | Postseason | 13.9 ± 0.8 | 13.8 ± 1.2 | 13.8 ± 1.0 | | | |
| | Effect size | 0.31 (-0.25,0.86) | 0.32 (-0.34,0.97) | 0.36 (-0.07,0.78) | | | |
| Vertical Jump (cm) | Baseline | 36.9 ± 5.2 | 36.4 ± 5.1 | 36.7 ± 5.1 | 0.60 | 0.94 | 0.67 |
| | Postseason | 37.2 ± 4.1 | 36.1 ± 6.1 | 36.7 ± 5.0 | | | |
| | Effect size | -0.06 (-0.62,0.49) | 0.05 (-0.6,0.71) | 0.00 (-0.42,0.42) | | | |
| Static Plank (sec) | Baseline | 52.3 ± 22.9 | 63.2 ± 41.9 | 56.9 ± 32.2 | 0.91 | 0.02 | 0.047 ^d |
| | Postseason | 78.4 ± 41.0 | 65.3 ± 32.9 | 73.0 ± 37.9 | | | |
| | Effect size | -0.79 (-1.35,-0.2) | -0.06 (-0.71,0.6) | -0.46 (-0.88,-0.02) | | | |

IG= Intervention Group; CG= Control Group; LESS= Landing Error Scoring System; YBT= Y-Balance test.

^aValues are presented as mean ± SD. ^bSignificant difference from Time 1 to Time 2 for all athletes.

^cValues are presented as effect size (lower, upper limits of 95% confidence level) ^dSignificant difference between groups from Time 1 to Time 2.

**Figure 2.** Rating of FIFA 11+ program.

unpleasant” or “slightly unpleasant” (Figure 2). Ninety-four percent of the exercises reported as the hardest to complete were from Section 2 – the strength, plyometrics, and balance components (Figure 3). In contrast, when reporting the easiest exercises, there was a relatively even distribution between Section 1 and Section 2 exercises (Figure 3). Movements that involved a partner were most

often reported as the girls’ favorite exercise (Figure 4). Of the girls who reported an inability to complete all the exercises, five described not being able to do one exercise and one girl reported an inability to do four exercises (Figure 5). None of the girls reported an inability to complete the eccentric hamstring exercise.

DISCUSSION

This study is the first to investigate the physical performance effects of the FIFA 11+ program on 9-11 year-old female soccer players. All athletes tolerated the intervention well and were able to participate in every exercise at some level.

LESS Score

The girls in the IG did not demonstrate better LESS scores compared to the CG after participation in the 11+ program; both groups improved overall. No studies could be found that used LESS score to gauge the effect of the 11+ program on neuromuscular control; however, similar interventions that included

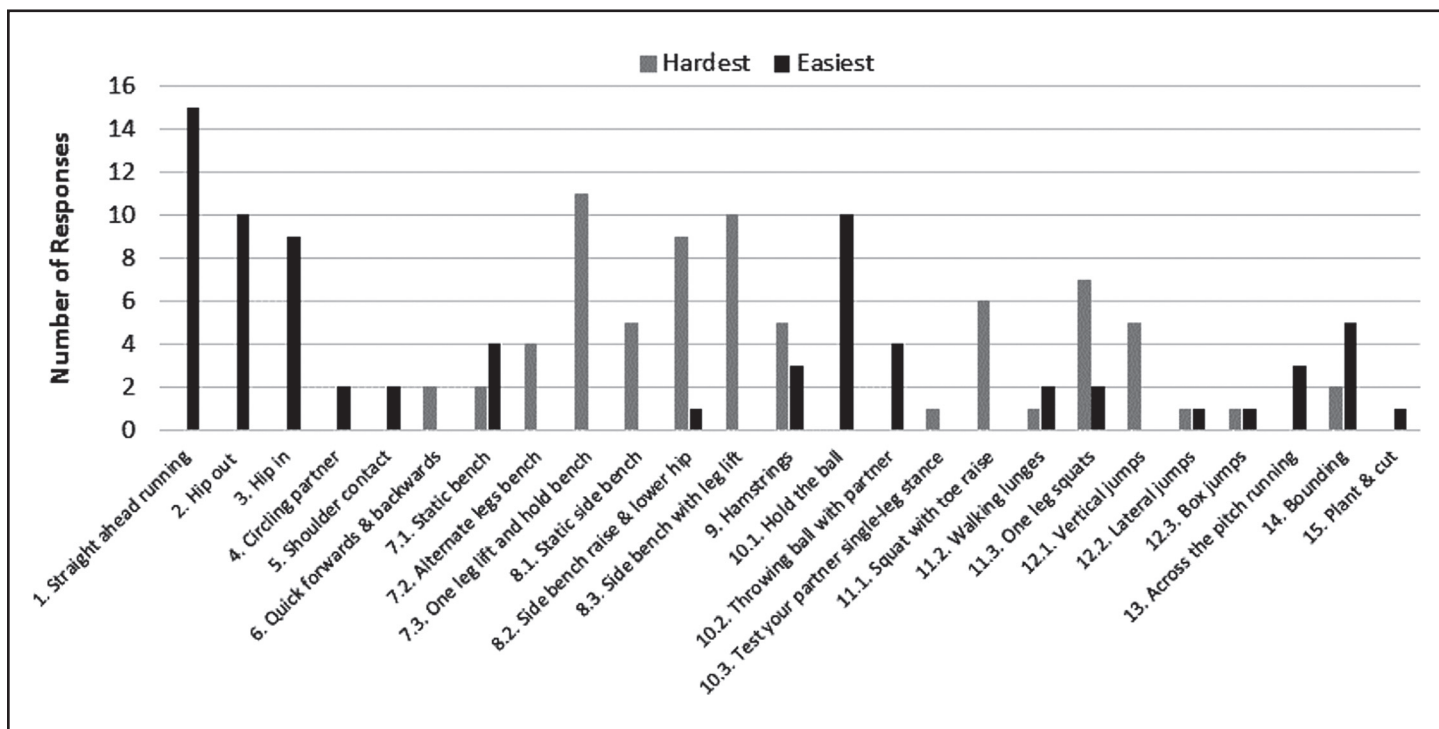


Figure 3. Self-reported hardest and easiest FIFA 11 + exercises (three per athlete).

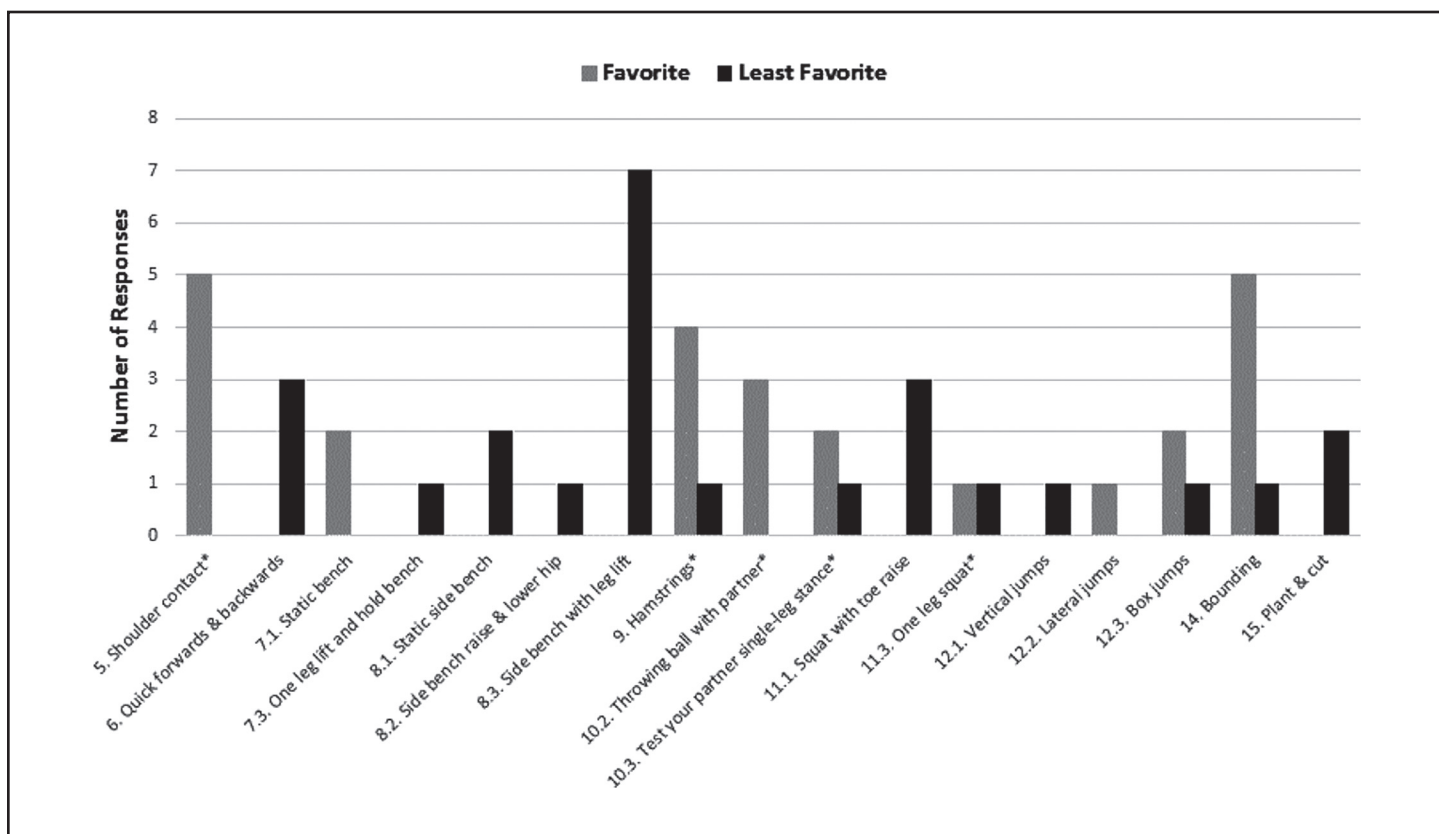


Figure 4. Self-reported favorite and least favorite FIFA 11 + exercises (1 per athlete). * denotes exercises that involve a partner.

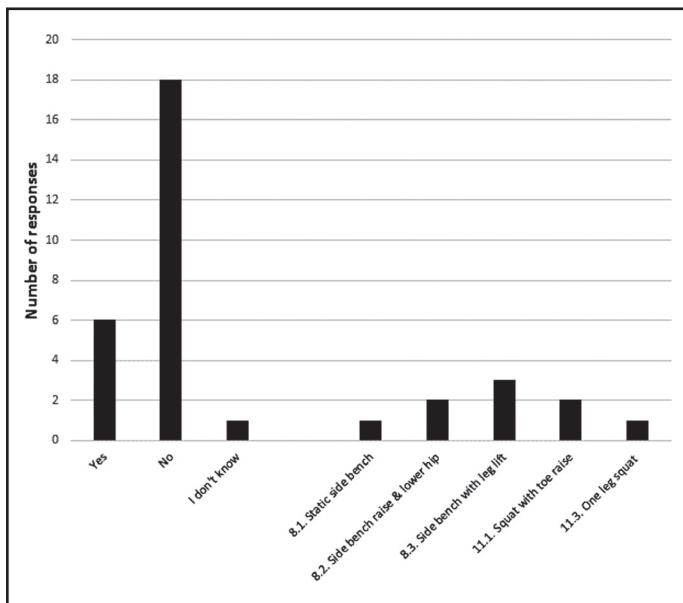


Figure 5. Left: Individual athlete responses to “Were there are any FIFA 11 + exercises you were unable to do?”. Right: If “yes”, exercises the athletes reported an inability to complete.

stretching and strength exercises have improved LESS score in youth soccer athletes.⁵⁰ Previous work using 3-D motion analysis measures of neuromuscular control in 10-12 year old female soccer athletes found a significant improvement in knee valgus moment during a jump task after participation in the 11 + program compared to a control group.²⁴ Both knee valgus moment and peak valgus angle during a jump task improved significantly more after the 11 + intervention in the 10-12 year old athletes compared with the 14-18 year old age group.²⁵ Results for other outcomes in these studies varied; peak knee valgus moment during unanticipated cutting worsened after participation in the 11 + program, and the control group significantly improved knee valgus angle during a cutting activity compared to the intervention group.²⁴ These results suggest that the 11 + program is successful in achieving improved movement control when landing from a jump, but this may not carry over into cutting activities. Indeed, the 11 + includes more jumping activities than planting and cutting tasks.¹³ Considering that soccer commonly involves cutting to change directions, more emphasis may need to be placed on developing safe movement patterns specific to that task.

The LESS scores in this study (>6) suggest that all the athletes were at greater risk of sustaining an ACL

injury, based on previous research that proposed a score of 5 as the cutoff point.¹⁰ Although the teams were playing at the developmental level, they would not be classified as “elite” athletes, as found in the Padua et al. study,¹⁰ and so the relevance of this risk classification to the current study population is unknown. Nevertheless, it is worthy of note, particularly as previous work suggests that neuromuscular control deteriorates with age in female athletes.⁵¹

YBT

Contrary to a previous study involving adolescent female athletes,³⁰ participants did not show an improvement in YBT score after the 11 + intervention. In fact, performance on this test worsened from pre- to post-test for all the soccer athletes. Steffen et al.³⁰ found that improvement on this test only occurred among athletes who were most highly adherent to the program (on average 2.2 times per week). Frequency of exposure of the athletes to the intervention averaged 1.3 times per week in the current study. Test day conditions, including fatigue levels, and nutrition and hydration intake, were not monitored, and may also have played a role in the decrease in scores.

T-test

In a previous study of male adults,³¹ no improvement in agility was observed after a nine week intervention. The groups in the current study did not differ in the change in T-test time; both groups showed faster test times after the intervention period. Agility and speed are skill-related physical fitness components that require specific stimuli to develop.⁵² The warm-up activities in both the groups may have provided appropriate stimuli for improved performance, perhaps influencing the 2-3% improvement in T-test time observed in all athletes.

Vertical Jump

No difference between groups or with time was observed in VJ performance, comparable to results found with female high school soccer athletes participating in the precursor to the 11 + on average 1.5 times per week.⁵³ In contrast, VJ increases were found in adult male athletes using the 11 + warm-up,^{27,28} and 10 year old soccer players employing a similar neuromuscular training program.^{21,54} Frequency

of training was 2-3 times per week in those studies, compared to 1-2 times per week in the current study. The VJ is an indirect measure of leg power (a combination of force and velocity).⁵⁵ The emphasis during the jumping exercise in the 11 + program is on maintaining proper neuromuscular control and alignment of the knees and the body. Athletes complete two sets of repeated jumps for 30 seconds, with instructions to slowly flex and pause at the end of the descent. This was likely an insufficient stimulus to increase muscular power, especially with the low frequency of training in this study.⁵²

Static Plank

Previous studies of FIFA programs^{21,29} did not find group differences when assessing trunk muscle endurance via static plank in male youth athletes. Conversely, the increase in static plank hold time was significantly greater in the IG compared to the CG. "The 11" program used by Kilding et al.²¹ prescribes about half of the static planking repetitions of the 11 + program, and the interventions in both studies^{21,29} lasted only four to six weeks compared to the five month duration of the soccer season in the current study. The advantage of the 11 + program is the inclusion of strengthening and proximal control exercises in Section 2. These types of exercises are necessary components of injury risk reduction programs for young female athletes.⁵⁶ Unfortunately, because this section of the program takes the longest to complete, and the exercises can be very challenging for athletes,²¹ it is often the portion that is omitted if time is limited.

Tolerance and Enjoyment questionnaire

Mirroring previous findings related to "the 11" program,²¹ the majority of athletes in this study described the pleasantness of completing the FIFA 11 + program as moderately low. The fact that the 11 + program often took 30 minutes to complete may have contributed to the low rating, especially considering the younger age of these athletes, for whom focus and concentration was an issue at times. This lack of enthusiasm demonstrates that players identify personal barriers to completion of the 11 + program, compared to coaches who report logistical barriers such as time and space as most significant.⁵⁷ Few authors⁵⁸ have singled out the importance of the athletes'

perspective in the design of injury risk reduction programs. Questions regarding athletes' opinions on the 11 + program were recently included on study questionnaires;^{45,57} however, it seems the results have not yet been reported. Traditionally, the coach has been the target for disseminating injury risk reduction strategies,^{59,60} but if the interest of the athletes is not considered, the appetite for conducting the program may soon diminish. Coaches report low confidence in the ability to sustain the use of the 11 + program if athletes do not enjoy the selected exercises, regardless of their proven injury risk reduction effect⁵⁷.

Limitations & Future Research

A number of limitations should be considered when interpreting the results of this study. First, the Tolerance and Enjoyment Questionnaire did not undergo validity or reliability testing before use; future investigation in this regard is warranted. Second, the parents and coaches were asked to regularly update attendance via a team management app (TeamSnap, Boulder, CO). The number of athletes who completed the 11 + program if they attended practice (adoption)⁶¹ was not officially monitored. However at the observed practices, if athletes were present, they completed the program. The only exception was if an athlete arrived late and missed part of the warm-up. This was not recorded.

In addition, the CG coaches in the current study proceeded with the warm-up they had planned for the season. At two observed CG practices, the approximately 10 minute warm-up consisted of agility drills, plyometric movements, and running drills incorporating dynamic stretches. The similarity in some of the exercises between the CG and IG may have affected the ability to distinguish a difference in physical performance between groups.

Challenges were encountered with the initial intent of exposing the IG to the 11 + program at least two times per week. Practices were sometimes cut short by school activities, which received precedence over external gym bookings. In those cases, the IG coaches shortened the 11 + program (with Section 2 exercises often the ones eliminated) in order to devote more time to soccer specific drills. Finally, there was no control for cluster randomization in this study, due to the limited sample size.

These findings may not be generalizable to athletes of different playing levels or young male athletes, and so exploring the effect of the 11 + program with these populations in future research is warranted. Given that more than half of the athletes in the current study did not find participation in the 11 + program overly pleasant, investigation into factors that would promote adherence to the program in younger soccer players would also be of benefit.

CONCLUSION

Female soccer athletes as young as nine years old can participate fully in the FIFA 11 + program and the warm-up can better improve trunk muscle endurance compared to a standard dynamic warm-up over an indoor soccer season. Improvements in LESS scores and agility times are similar to those seen with a standard warm-up, but balance abilities decreased among all athletes. Although the 11 + program often requires more time to complete than a standard warm-up, strong evidence supports its ability to prevent injury.^{15,16} By choosing the 11 + program, this study suggests that female athletes under the age of 12 may also experience some physical performance benefits from the program; however, athletes' perceptions of the program should be considered when planning for longer term adherence.

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